# RESPONSE OF SCINTILLATING SCREENS TO FAST AND SLOW EXTRACTED BEAMS*

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During the last years a significant increase of interest for inorganic scintillators in beam diagnostics applications has occurred [1]. To fulfil the challenging requirements for FAIR concerning precise beam profile measurement (linearity of response over a large dynamic range, harsh radiation environment), experiments were conducted at SIS18. Furthermore, the stability of various scintillator materials has been studied to identify radiation hard scintillators.

## Results

Experiments were performed at GSI to characterize the inorganic scintillator response to slow (within 200 ms, SE) and fast (within 1 µs, FE) extracted 350 MeV/u Uranium beams from SIS18. The extracted particle number was varied between $10^5$ and $10^9$ particles per pulse (ppp) for the irradiation of 7 different scintillators, mainly a number of YAG-crystals with different qualities as well as pure and Cr-doped alumina-ceramics and two phosphor powders – P43 and P46.

A detailed description of the chosen experimental setup can be found in [2]. To increase the dynamical range of the DAQ system a second CCD camera of the same type with 5% transmission filter was mounted in parallel. With this system the emitted light of the scintillating area in 45° backwards direction to the beam (light output) was observed.

With a dedicated code written in Python the images were analysed concerning region-of-interest cutting, background subtraction and scaling of the optical parameters. As an example for the various materials under investigation, the light output of the P43 phosphor screen is displayed in Figure 1 as function of ppp. For each individual beam setting 30 images were taken.

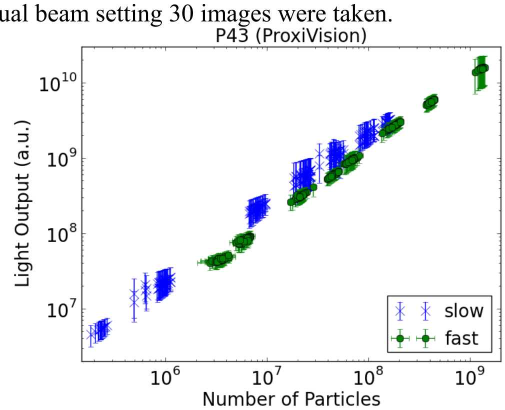


**Figure 1:** Comparison of P43 phosphor screen light output for SE and FE Uranium beam vs. particle number. Beam parameters: 350 MeV/u Uranium beam, pulse lengths 200 ms for SE (green circles) and 1 µs for FE (blue crosses).

The data show a linear response over a large range of ion intensity. No significant difference between SE and FE beams has been observed. The displayed trend is characteristic for all investigated scintillators.

Radiation hardness tests for all phosphor screens and the Cr-doped alumina screen were performed by irradiation with more than 700 pulses of $\approx 10^9$ ions each. Figure 2 shows the light output of P43 phosphor screen measured with the FE beam as function of accumulated number of ions. Its linearity seems to be different from previous observations on SE beams [2] with comparable beam parameters. An explanation of this unexpected behaviour needs further beam-based investigations.

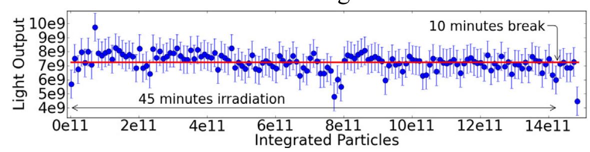


**Figure 2:** Radiation hardness test for FE Uranium beam on P43 target. Light output is approximately constant even after 45 minutes of permanent irradiation; its average is represented by the straight line. No discontinuity after 10 minutes beam pause could be observed. Beam parameters: 350 MeV/u Uranium beam, pulse length of 1 µs, 0.25 Hz repetition rate and $10^9$ ppp.

Among the investigated materials different light outputs were recorded as expected from previous experiments [1-3]. For the given beam intensities no significant decrease of the light output caused by radiation induced material modifications was observed for all investigated materials. The sensitivity of P43 proves stable during continuous irradiation. Further investigations and material characterizations are necessary to understand the ion beam induced radiation changes in scintillating screens. The performed studies help to choose appropriate scintillator materials for the FAIR facility, which will deliver about a factor of 100 higher beam intensities as presently available. Therefore long term stability and performance during fast extraction of intense beams is a critical issue.

## References

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